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REVIEW

# Implementation and application of extended reality in foreign language education for specific purposes: a systematic literature review

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## Abstract

**Purpose** Extended Reality (XR) applications such as Augmented, Virtual and Mixed Reality have extensively supported foreign language education for specific purposes, creating opportunities and challenges that are different from the ones in general foreign language contexts. However, there is a lack of comprehensive description of XR applications aiming to support language learning for specific purposes. This study was conducted to fill this gap by reviewing the state-of-the-art technology in the use of XR for language learning for specific purposes.

**Methods** Published manuscripts during the period 2020–2024 were searched electronically with an eye to retrieve recent relevant published literature on the topic. The criteria for inclusion in the final review were met by a total of 33 articles.

**Results** The analysis indicated six types of tasks being employed in the use of XR for specific purposes (i.e., role playing, peer tutoring/dyadic task, informal discussions, closed outcome tasks, XR environment exploration, and XR content creation). Primary purposes and benefits of XR technologies were identified: authentic contexts, oral proficiency improvement and development of communication skills, creative thinking, improvement of long-term memory, motivation, and students' multimodal literacy.

**Conclusion** Increased attention was directed toward VR applications for language learning for specific purposes. Both students' and teachers' familiarity with XR technologies plays a crucial role in their overall learning and teaching experience. The added value of XR in the teaching and learning circumstances should be taken into consideration. Implications for educators and future research are suggested.

**Keywords** Language learning for specific purposes · Foreign language learning · Mixed reality · Virtual reality · Augmented reality · Extended reality

## 1 Introduction

Technology has become a part of our everyday lives and has inevitably affected education, including the teaching and learning process. Learning a Foreign Language (FL) is a crucial educational topic that can become more immersive and interactive with the support of emerging technologies. Language experts have been interested in using Extended Reality (XR) technologies in education, particularly in language learning, for the last two decades [1–4]. XR encompasses all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables such as Virtual Reality (VR), Mixed Reality (MR) and Augmented Reality (AR). XR technologies can either fully immerse users in virtual worlds or integrate the real world with the virtual one [5, 6]. VR holds the potential to be a fully immersive multimedia reality when a head-mounted system is employed and the user is unable to gather more spatial information from their surroundings [7], whilst AR combines real environments with virtual, computer-generated elements [8]. Compared to VR and AR, MR

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as a term has not seen a consistent use. There are multiple competing definitions for this term [9]. In specific contexts, it includes both AR and VR, whilst in others, it represents the midpoint of the reality-virtuality continuum; the point where real and virtual elements are equally displayed for the user.

### 1.1 Rationale

The implementation of XR in education and language learning in particular has a great potential on the cognitive, academic, and linguistic levels [8, 10–16]. Previous systematic literature reviews have explored the use of XR in language learning in general (e.g [3, 12, 17]). For instance [18], analyzed 36 studies and provided a thorough review of the trends in the incorporation of XR into English language instruction, along with useful recommendations for academic institutions, researchers, and teachers. On the other hand, drawing on 20 meta-analysis studies published in international journals [19], concluded the effectiveness of XR for language teaching and learning, indicating that XR technologies can improve teaching. Although the above studies enrich the literature on XR for generic language learning, aspects that focus on language learning for specific purposes that call for specific attention, are left unexplored. A systematic literature review of the recent use of virtual, augmented, and mixed reality applications for language learning for specific purposes is currently missing. Aiming to address this gap, the current study focuses on XR in Foreign Language Education (FLE) for specific purposes globally.

Language instruction for specific purposes is goal-oriented and based on the specific needs of the target group [20, 21]. XR offers an abundance of opportunities in language practice for specific purposes (e.g. VR for learning English for aviation [22] ). At the same time, the rapid advances in technology [4], call for a summary of XR applications for language learning for specific purposes. Setting out to address the issues above, the present systematic review is timely for two reasons: first, it summarises recent empirical findings on the potential of XR on language for specific purposes, thus supporting policymakers, instructional designers, researchers and practitioners in making evidence-based decisions related to the development of XR in the language teaching and learning. Secondly, it is timely in providing relevant parties a review with up-to-date insights pertaining to benefits, facilitators, promoting factors, barriers and potential pitfalls related to the implementation and application of XR in FLE for specific purposes, as well as classroom orchestration and task design practices.

### 1.2 Research questions

The following research questions guided this study:

1. What XR (AR or VR or MR) applications are being employed in FLE for specific purposes?
2. What are the benefits, facilitators, promoting factors, barriers and potential pitfalls related to the implementation and application of XR (AR or VR or MR) in FLE for specific purposes?
3. What classroom orchestration and task design practices have been applied in the use of XR in FLE for specific purposes?

In the following sections, the methodology of the study is described, followed by the findings, conclusions and implications for educators and future research.

## 2 Methodology

In order to capture a broad overview of XR for language learning for specific purposes we employed the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) approach [23], which is considered a well-grounded approach to a systematic literature review. We searched for academic literature published between 2020 and 2024, a time span that provided a wide range XR applications in language learning for specific purposes.

### 2.1 Protocol

A predefined protocol was used in order to minimize the researcher bias [24] following the PRISMA approach. Figure 1 presents the systematic literature review process. Five phases of conducting the search were (1) Plan, (2) Conduct, (3) Iterations, (4) Dataset finalisation and data extraction and (5) Conclusions. In the first phase (Plan), the need for systematic literature review was identified and the research questions were defined. Then, the search databases were decided and the query string to be searched was defined. In the second phase (Conduct), the database search was conducted, and relevant papers were extracted. The inclusion and exclusion criteria were defined. In the iteration phase (third phase), forward and backward search was performed to find additional papers related to XR for language learning for specific purposes. In the fourth phase, the dataset was finalised by applying the predefined inclusion and exclusion criteria, the data were extracted and synthesised. Finally, in the final phase the conclusions, implications for practitioners and researchers, as well as the study limitations were presented.

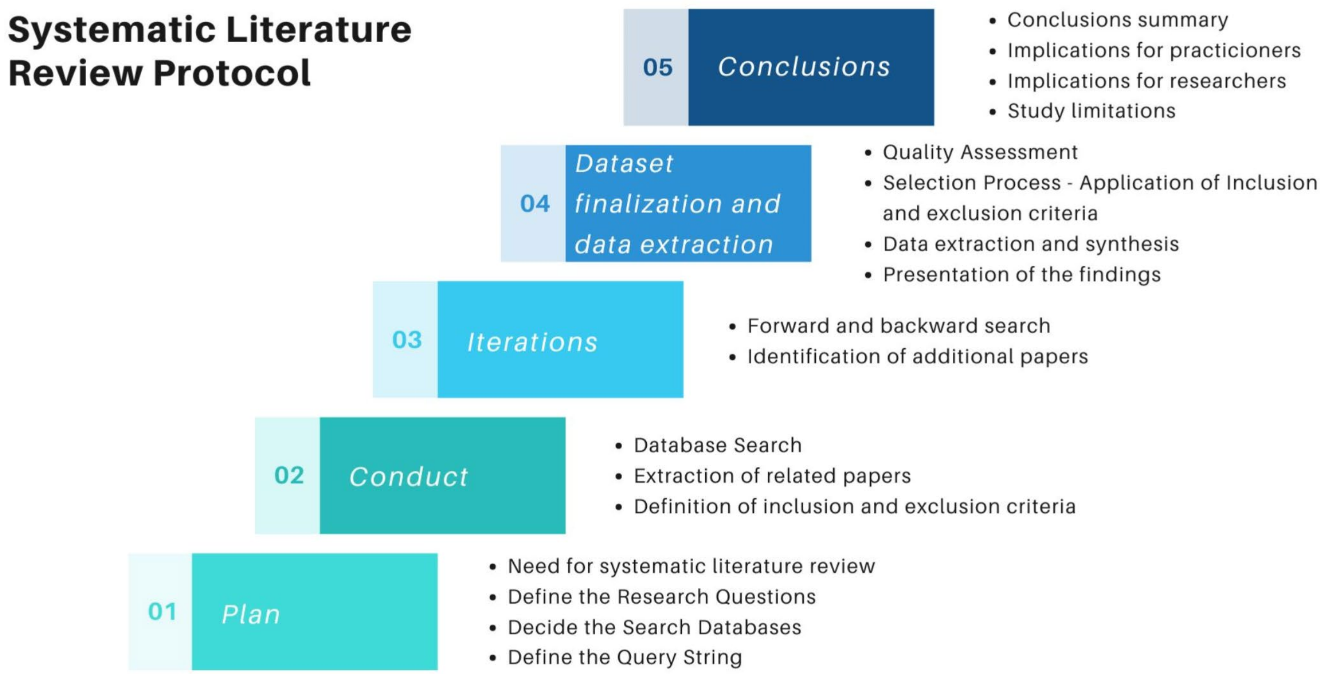


**Fig. 1** Systematic literature review protocol

**Table 1** Database search results

| Database | Notes | Results |
|---|---|---|
| Scopus | - Search on the fields "Abstract", "Title" and "Keywords" | 103 |
| Web of Science | - All fields Search | 551 |
| ERIC (via Ebsco) | - All fields Search | 144 |
| Total | | 798 |

## 2.2 Search strategy

Published manuscripts during the period 2020–2024 were searched electronically with an eye to retrieve recent relevant published literature on the topic and recent XR applications. The specific timeframe was selected to capture a contemporary and comprehensive overview of XR in language learning for specific purposes. In the identification phase, previous research on XR and the terms used in the relevant literature informed the list of keywords for information search. Three online research databases (Scopus, Web of Science, ERIC via Ebsco) were used in order to find relevant literature sources related to XR applications for language learning for specific purposes. The specific databases were chosen as they provide access to quality, peer-reviewed journals related to education and technology. The last search was conducted on the 5th of June 2024. Table 1 presents the number of the results extracted from each database.

The Boolean strings used were based on combinations of XR and language for specific purposes, such as ("Virtual Environment" OR "immersive environment" OR "Virtual Reality Learning Environment" OR "Virtual Reality Environment" OR "virtual world" OR "VR" OR "VRLE" OR "virtual classroom" OR "virtual class" OR "augmenting reality" OR "mixed reality" OR "mixed reality environment" OR "mixed reality instruction" OR "mixed reality learning") AND ("language learning" OR "computer assisted language learning" OR "technology-enhanced language learning" OR "VRALL" OR "VR-assisted language learning" OR "language course" OR "language classroom" OR "Language education" OR "Foreign language" OR "Second language" OR "Language acquisition" OR "Language teaching" OR "Language learning" OR "Language classroom" OR "L2" OR "language teach*" AND "ESP" OR "language for specific purposes" OR "English for specific purposes" OR "English for specific academic purposes" OR "vocational English" OR "workplace communication" OR "communication competence" OR "English communication" OR "English for occupational purposes" OR "EOP").

## 2.3 Inclusion and exclusion criteria

The search returned 798 results based on the query string searched. A set of inclusion and exclusion criteria were applied during this review to aid in the selection of relevant manuscripts (see Table 2). Automation tools from the databases, such as limiting the results within the selected timeframe and English language for full text were decided to narrow down the results based on these criteria and

**Table 2** Inclusion and exclusion criteria

| | Inclusion criteria | Exclusion criteria |
|---|---|---|
| 1 | The manuscript should have been published between the years 2020–2024 | The paper was published before 2020 |
| 2 | The manuscript should involve empirical data on XR (AR or VR or MR) applications for language learning for specific purposes (e.g. English for academic/specific academic purposes, professional English, etc.) | The paper was a review or did not include empirical data related to the use of XR (AR or VR or MR) applications for general second/foreign language learning |
| 3 | The manuscript presented sufficient data to identify how an XR (AR or VR or MR) application was used | The manuscript was a short paper that did not provide sufficient data on the XR application implementation (e.g. abstract papers, poster, presentations, scientific events program, tutorial slides, literature reviews, book reviews or editorials) |
| 4 | The manuscript was written in English | Publications written in a language other than English were excluded |
| 5 | Publications should be accessible to the authors | Publications that were not accessible (required to pay or could not access by the authors' institution for any other reason) were excluded |
| 6 | The manuscript should refer to adult learners (adult learners, university students, professionals) | The manuscript refers to learners other than adults (e.g., middle school or high school students, etc.) |

duplicated results were excluded. Subsequently, the titles and abstracts were reviewed to test their appropriateness for the study's purposes. Studies were eligible for inclusion in the corpus if they met the criteria outlined in Table 2. The PRISMA guidelines [25] were followed to depict the process and present the number of the papers retrieved, the reasons for exclusion, as well as the final number of the papers included (see Fig. 2).

### 2.4 Iterations

The forward and backward search was used to find additional papers related to XR for language learning for specific purposes. The references of the included papers were reviewed and relevant papers were added to the corpus. Through this process, eleven (11) new papers were found, although only six (6) additional studies met the inclusion and exclusion criteria and were included in the corpus.

### 2.5 Selection process

To eliminate bias and ensure quality, more than one researchers screened the corpus as suggested by Xiao and Watson [26]. Three researchers reviewed the results independently and in parallel to finalise the corpus and the suitability of the manuscripts. Disagreements between the three researchers were settled through discussion on the disputed studies until agreement was reached. The criteria for inclusion in the final review were met by a total of 33 articles.

### 2.6 Quality assessment

The publications included were restricted to peer-reviewed journal articles. The screening of publications for quality should verify that there is sufficient data to address the research questions [27]. To make sure that the papers have enough readily accessible information, extra quality criteria were established as follows:

1. Does the manuscript focus on XR application for language learning for specific purposes?
2. Does the manuscript provide enough information (e.g. learning experience design, duration of task) to answer the research questions?
3. Is there more information available about the XR application for language learning for specific purposes than the paper summary in English?

One paper was excluded during quality assessment since it was retracted.

### 2.7 Data extraction and synthesis

All manuscripts of the corpus were thoroughly read by the first author of this manuscript and information was extracted using the authors' own words (see Table 3 for Information Extracted, IE). The second author worked independently from the first author to confirm the extracted data. The IE from the chosen publications was the basis for the synthesis (Data available from the corresponding author, upon request). Each IE was synthesized with an eye to find common themes, working back and forth until all data could be classified to categories. To create categories, we used an inductive approach, which allowed for the emergence of themes or categories from the dataset.

## 3 Findings

This section provides an overview of the findings retrieved from our review.

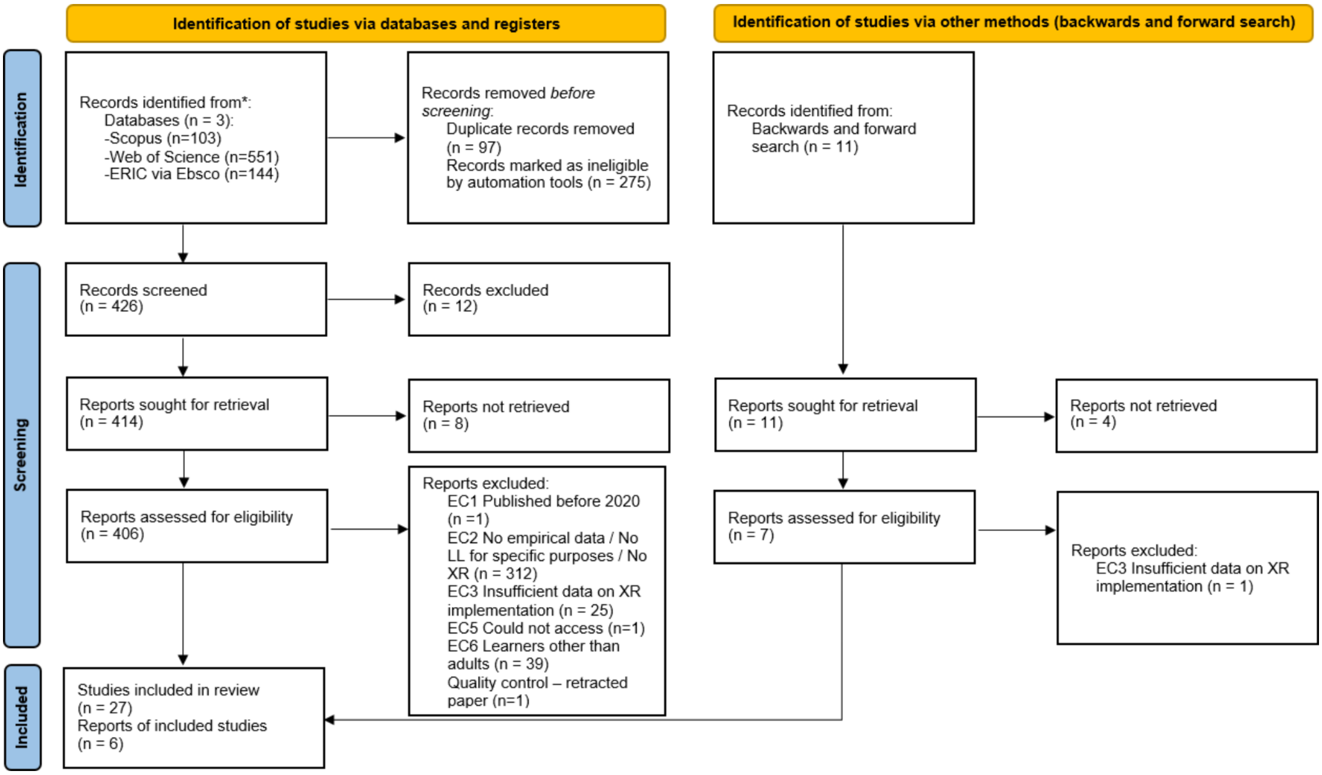


**Fig. 2** PRISMA diagram

**Table 3** Data categorisation and information extracted (IE) based on [28]

| Group 1. Material identification | Group 2. Activities reported in the material |
|---|---|
| IE1. Material ID<br>IE2. Material title<br>IE3. Year of publication<br>IE4. Authors' name(s)<br>IE5. Source of the material | IE6. Application name<br>IE7. Level of immersion<br>IE8. Context<br>IE9. Short description of the application |
| **Group 3. Basis of the publication** | **Group 4. Evaluation of material** |
| IE11. Type of hardware<br>IE11. Target group<br>IE12. Language<br>IE13. Technology used<br>IE14. Facilitating Factors<br>IE15. Instructional design /Learning design experience<br>IE16. Classroom orchestration<br>IE17. Type of task design<br>IE 18. Intended Outcomes | IE19. Benefits<br>IE20. Barriers/ Disadvantages/ Potential pitfalls<br>IE21. Stakeholders' acceptance |

### 3.1 Existing XR technologies for FLE for specific purposes

The literature demonstrated a variety of existing XR applications for language learning for specific purposes (See Table 4). The majority of the technology used was VR ($n$=28/33), including four (4) manuscripts that examined the use of VR combined with 360-degree videos [29–32], one (1) that examined the use of VR combined with 3D technology [33]] and one that examined the use of VR with AI [34]. One study also described the use of VR, AR and AI [35]. Four (4) out of the 33 papers were found to examine the use of AR technologies [36–38] while only one paper was found to refer to the use of MR technologies [39].

Second Life (SL) and EduVenture are the most popular applications in the corpus. SL is an internet-based, 3-dimensional virtual world that has been created by Linden Labs Company in San Francisco [40]. There are many opportunities in SL that are suitable for teaching and learning other languages for specific purposes. Students can interact with native speakers of the language in a virtual setting, be exposed to a wealth of authentic input, take on different roles that will help them use the language in a more natural context, and work together to accomplish challenging tasks using suitable media such as text, voice, and video [41]. SL has been employed as a research tool in the study of [40] for developing English as a foreign language for undergraduate students' English communication skills.

In EduVenture, 360-degree videos, or spherical videos are produced with a camera that can record and capture a screen presenting content from all angles. Students can work with a variety of information modalities (including still photographs, panoramas, audios, videos, and texts) to create VR material. In the study of [42] EduVenture was

**Table 4** Existing XR applications

| Technology | Application name | Number of manuscripts |
|---|---|---|
| VR Applications ($n=28$) | Second Life (SL) | 4 |
| | EduVenture VR | 4 |
| | Comunica-Enf. | 1 |
| | Modern Operation Room (MOR) | 1 |
| | Google Tour Creator | 1 |
| | Edmersiv | 1 |
| | Enduvo | 1 |
| | Mozilla Hubs | 1 |
| | INSTA360 app | 1 |
| | VR scenario app | 1 |
| | Uptale | 1 |
| | Ifland | 1 |
| | Robot-assisted VR-based tour guide | 1 |
| | Self-developed VR app | 6 |
| | Not specified VR environments | 3 |
| | ***Total VR applications*** | ***28*** |
| AR Applications ($n=4$) | Unity Mobile AR | 1 |
| | ChronoOps AR app | 1 |
| | HP Aurasma | 1 |
| | Self-developed AR app | 1 |
| | ***Total AR applications*** | ***4*** |
| MR Applications ($n=1$) | Virtual English Classroom Augmented Reality (VECAR) | 1 |
| | ***Total MR applications*** | ***1*** |
| ***Total*** | | ***33*** |

employed for electric and mechanical students to engage in problem-solving tasks and generate possible solutions by designing and sharing VR content through spherical videos on mobile-rendered head-mounted displays (HMDs).

Other VR applications found in the corpus include *Modern Operation Room (MOR)*, a newly created VR teaching tool that intends to give nursing students the chance to experience a simulated operating room and practise performing surgery before they can become licensed nurses. It presents virtual healthcare scenes to the participants [43]. Additionally, *Google Tour* application which allows users to use Google's street-view technology to build tours on their computers [44] and Enduvo software platform [45] for VR scenarios in clinical contexts were used.

There were also three (3) studies that the VR application used was not specified, however, two of them referred to virtual reality learning environments (VRLE) [46, 47], while others referred to VR environments in general (e.g [48, 49]).

AR Applications that were found in the corpus include *ChronoOps*, an AR GPS-enabled place-based game [37], and HP Aurasma. Unity for mobile AR app was also used for creating an augmented-reality context-aware ubiquitous writing (ARCAUW) application [36] and finally a self-developed [38] for supporting Multimedia English students.

The only MR Application that was found in the corpus is *Virtual English Classroom Augmented Reality (VECAR)*, a virtual environment that offers 360-degree street-level footage of well-known locales all around the world, enabling virtual access to context-sensitive learning environments for contextualized vocabulary learning in real-world situations. VECAR is considered a blend between VR and AR that involves projections of real-world images into virtual spaces. This description is aligned with the definition of Mixed Reality as per [9], where MR refers to a combination of AR and VR. Through VECAR, language learners can explore actual street view sceneries and interact with virtual things or other avatars by using virtual avatars in conjunction with real street views [39].

The language focus of the corpus was English (25 out of the 33 manuscripts), focusing either on English for academic purposes (i.e. courses that aim to help learners to study, conduct research or teach in English [21]) or English for specific academic purposes such as tourism ($n=3$), business ($n=2$), engineering ($n=1$), humanities ($n=1$) etc. Three papers referred to English/Chinese Interpretation/Translation, one to Spanish for medical purposes, while one paper didn't specify the target language. Table 5 summarises the language focus of the manuscripts.

**Table 5** Language focus

| | | | | |
|---|---|---|---|---|
| **Language Learning for Academic Purposes** | | | **16** | **48.48%** |
| - English for Academic Purposes (EAP) | | 16 | | |
| **Language Learning for Specific Academic Purposes** | | | **17** | **51.52%** |
| - Language for Specific Academic Purposes | | 17 | | |
| - English for tourism | 3 | | | |
| - English for nursing | 1 | | | |
| - Multimedia English | 1 | | | |
| - English/Chinese Interpretation/ Translation | 3 | | | |
| - English for Geography | 1 | | | |
| - Medical Spanish | 1 | | | |
| - English for electric and mechanical engineering | 1 | | | |
| - English for humanities | 1 | | | |
| - English for engineering | 1 | | | |
| - Airline English | 1 | | | |
| - Business English | 2 | | | |
| - Not specified language targeted for nursing | 1 | | | |
| **Total** | | | **33** | 100% |

## 3.2 Benefits related to the implementation and application of in FLE for specific purposes

The application of XR in FLE for specific purposes comes with many advantages as it can be seen from our dataset. The benefits of XR can be classified into the four categories appearing below, with a reference to the number of studies that highlighted each benefit category. The total number of studies exceeds the number of the dataset as some of the manuscripts demonstrate more than one benefit.

### 3.2.1 Creation of authentic contexts for foreign language use, initiation of real-world linguistic interactions for specific purposes and enhancement of language learning experience ($n = 13/33$)

VR can break the time and space limit and offer a "real" environment for students to interact freely, cooperate with their peers and engage in meaningful, real-life-like language use as reported in several studies [33, 45, 48, 50]. Within XR, context-specific practice is beneficial for students' authentic language use in an environment that is error-safe. For example, the use of 3D serious games in nursing education can enable students to practise their communication skills by simulating real-life scenarios which can lead to the improvement of the students' linguistic productivity [33]. Virtual characters, locations, and VR-based activities in [51] allowed students to practice speaking for engineering purposes in real-world situations. Another benefit pertains to the role of immersive VR, especially in pragmatics task development, since the VR authentic and realistic settings allow learners to practise and develop pragmatic skills, which are essential for communication [48]. The studies also demonstrated cases where students valued the experiential aspects of immersion. The scenery-based VR environment supported dyadic learning related to students' language production in specific subjects such as English for Tourism Purposes (ETP) [52].

### 3.2.2 Language proficiency improvement in specific contexts and development of students' multimodal skills ($n = 19/33$)

XR entails the potential to improve language proficiency in specific contexts and develop students' multimodal skills. Multimodal skills are the abilities to use and integrate multiple modes of communication simultaneously, such as visual, verbal, textual, auditory, gestural and tactile channels [53]. The corpus brought to life cases where meaningful multimodal communication improved students' overall communication skills resulting from the usage of different semiotic resources and modalities (visual, textual, and interactive elements) to express their ideas to their viewers. Immersion, as a VR affordance, was found to be conducive to the students' improvement in the learning of paragraph structure and writing in EAP [46, 54], oral proficiency improvement and development of students' English communication skills through VR [34, 40], reading skills [29, 39] as well as content knowledge and vocabulary knowledge for specific purposes [34, 43]. More specifically, the interactive and authentic language practice scenarios within the virtual world of SL enabled Thai EFL learners' to practise their communicative skills in English more effectively [40]. Moreover, medical content knowledge and vocabulary for specific purposes [43] for Chinese college nursing students in the VR environment improved, while students found the simulated method of learning more innovative than traditional classroom teaching. On the same line, the usage of AR enhanced cognitive processes in writing [36], providing a context-rich environment that enhanced students' multimodal literacy [38]. AR also enhanced teamwork skills and critical thinking [34].

### 3.2.3 Positive impact on the students' efficacy for creative thinking, confidence and motivation ($n = 11/33$)

*Learning through VR arouses their learning motivation and can help built up learners' confidence* [55, 56] The hands-on opportunity for students in the L2 classroom to create content in the VR environment from scratch, enabled them to take the roles of English learner, user and VR creator and deal with multiple tasks and brainstorm new ideas and solutions [44]. Immersing students in stimulating and interactive environments has a positive impact on enhancing students' creativity and curiosity, leading to active participation and engagement in language learning in specific contexts [31]. Finally, VR tools can also improve students' motivation for example by visualising themselves in a specific role (e.g. health-care providers [45], and enjoyment [56]. Students in [57] learning English for humanities in VR and gained a sense of presence in the scene, which made language learning more interesting and intelligent.

#### 3.2.4 Practice of occupational, research or academic language skills in a flexible and safe environment ($n = 6/33$)

XR technologies provide opportunities for flexible learning and to practice language for specific purposes in safe environments. More specifically, the VR environment might reduce speaking anxiety for specific formal situations since learners can practice repetitively, allow learning without time or space limitations and provide a safe learning environment [32] Similarly, the learning flexibility and autonomy provided by the VR activity, as well as the ability to choose specific learning modes, may facilitate independent, active and ubiquitous learning [38, 55].

### 3.3 Facilitators, promoting factors and acceptance related to the implementation and application of XR in FLE for specific purposes

In this section, the facilitators, promoting factors and acceptance related to the implementation and application of XR in FLE are presented. They are categorised into factors that are encountered before, during and after the implementation of the activity, as they emerged from the corpus of manuscripts.

#### 3.3.1 Before the implementation of the XR-supported activity

Prior to the start of the course, teachers act as the activity planners [57]. The appropriate software and content based on the lesson objectives should also be selected [33]. Additionally, information on how to use and interact with the VR applications, as well as preparing the students and the teachers for the tasks before the implementation should be provided (e.g [33, 41, 46, 48, 50, 54, 58]). For example, in the study of [44] students were given a handout with information on fundamental SL operations like chatting, teleporting, looking at the SL map, and using their avatars, and they practiced these for a week. The researchers provided online assistance if they ran into any issues [44]. Software and equipment training is also important for both students and teachers (e.g [41, 43, 50, 58–60]). The authors in [61] suggest for remote teacher observation set up so that the instructor can monitor students' learning activities remotely.

The training sessions prevent students from feeling overwhelmed and confused when moving within the VR Learning Environments and make it easier for them to concentrate on the subject at hand [41]. For example, the study of [43] allocated 20 min on training teachers and students on how to wear the VR headset as well as how to use the controllers before the teaching activity [43]. It was also found that learners could use the technology on their own time and pace in order to familiarise themselves with it. In the study of [36], prior to starting the actual task at each level, the participants viewed AR learning materials at the learning site and spent nine hours on the AR-based practice and learning in total. Some students took the tablets and keyboards home to do the assignments [36].

Additionally, various facilitating tools were used by both the instructions and the students during the implementation of the XR-supported activity. Teachers in some instances were actively involved in the creation of the content for the XR-supported activities. More specifically, in [57] the teacher acted as the main planner and collaborated with the technical teachers to design and develop the VR teaching resources.

#### 3.3.2 During the of the XR-supported activity implementation

At the time the VR activity is taking place, not only students but also the instructors play an important role for the support and guidance of their learners (e.g [30, 36, 38, 41, 43, 61, 62]). During their experience with the VR, the participants in the study of [46] walked, exactly as they would in the real world, to manage their navigation within the virtual environment. They were told not to cross the blue net-delineated boundaries of the lab room while navigating and they were instructed to face the direction of an arrow that was placed adjacent to a virtual round frame/spotlight that was drawn on the ground. The participants were then asked if they were prepared to be automatically transferred to the environment and as soon as they gave their consent, they were virtually transported to the simulated room [46]. The need for instant support during the project, provided by teachers via email and a mobile instant messaging application was also highlighted in [31], with feedback aiming to meet the students' immediate needs.

In [41], students were paired up and given the roles of tutors and tutees. A tutor was physically present to make sure students could use the specific application (EduVenture), to help them if they felt unwell, and to provide them feedback on how they were doing on their tasks [41]. Similarly, in [30], in order to assist the students in resolving the challenges presented in the scenario during problem-based learning (PBL), the instructor offered a set of guided questions. In particular, the students were instructed to identify potential issues, look for reliable sources, come up with workable solutions, and consider their conclusions, while the instructor guided the procedure, monitored it, and held weekly progress meetings to ensure ongoing improvement.

In accomplishing AR-based learning tasks, when participants needed assistance with technology or wanted more detailed instructions, the instructor and teaching assistant served as facilitators in the study of [36]. In simple words, scaffolding is an important aspect to be considered both in the design as well as in the implementation of AR-based tasks.

To aid students' improvement of their English-speaking abilities, a progressive question prompt-based peer-tutoring strategy in VR situations (PQP-PTVR) is suggested by [42]. The English question prompt-based strategy gives tutors guiding questions so they can methodically direct students' exploration of the museum and aid in their understanding of the exhibition through questioning and giving feedback [42].

#### 3.3.3 After the XR-supported activity implementation

Students usually carried out reflective activities in order to evaluate their experience with the XR-supported activity implementation. For example, in [62], AR acted as prompt to sparkle students' thinking about a topic. After the AR-prompt, students were tasked to perform a writing task. Similarly, in [37], students were asked to make a video report based on the content explored in the VR.

### 3.4 Task design

A variety of task designs was identified which can be classified under six types: informal discussions; role play tasks; peer tutoring/dyadic task; closed outcome tasks, exploration of XR environment; and creation of XR content. Table 6 provides a brief description of the six task types, outlining the intended outcomes and potential pitfalls of each task type, as well as giving references to manuscripts where representative examples of each task type can be found. The total number of studies exceeds the number of the dataset as some of the manuscripts have used more than one task design. For instance [29] engaged students learners in a dyadic task that also involved exploration of the VR environment. Role-playing was the most popular task design as it allowed learners to follow a specific scenario, have a specific role (e.g. nurse) and communicate with other users (real or avatars) in a virtual environment, as well as more exploratory tasks (e.g. by being exposed to content intentionally integrated within a virtual environment for specific purposes) or more constructionist tasks that involved the creation of XR content.

### 3.5 Classroom orchestration practices

When it comes to classroom orchestration, in more than half of the studies ($n=19/33$) it was reported that students worked individually within the immersive environment while in one study [50], students worked individually and later engaged in a peer-review activity ($n=1/33$). Even though in [59] students worked alone in the virtual environment, the teacher was co-present but did not interfere. In one study ($n=1/33$) [61], suggest the use of teacher observation set up where the VR system simultaneously supports two groups: a user group with only one user (student) who operates VR and an observer group (teacher) who can view students' learning activities from a separate computer screen. The proposed approach made it possible to minimize any negative impacts of the observer's presence on students' interaction process. A combination of individual and pair/group activity was found in two studies ($n=2/33$), while group or pair activity was implemented in one third ($n=10/33$) of the studies. Specifically, in [29], students performed joint verbalizations in dyads to deepen the learning and activate knowledge co-construction. In the experimental study of [42], students were assigned roles of tutors and tutees with one tutor student being present in each group of tutees. A progressive question prompt-based peer-tutoring strategy in VR situations (PQP-PTVR) was suggested by [42] allowing for students to take the roles of tutors and tutees and either ask questions or provide guidance to their peers. Similarly, in the study of [37] students were in groups of L1 speakers of English (ESs) and English language learners (ELLs). While ESs' goal was to observe interactions involving language learners in real-world contexts and then relate their observations to SLA theories covered in their pre-service teacher training program, ELLs' goal was to engage in communication with a variety of speakers in relatively unstructured tasks outside of class. All students, both ELLs and ESs, wrote observations on the experience after the game. Similarly, in [51] students are split in small groups that role play in engineering scenarios. Each group is tasked to work on collaborative language learning projects such as engineering-themed virtual presentations.

### 3.6 Barriers and potential pitfalls related to the implementation and application of XR in FLE for specific purposes

The implementation of XR in FLE for specific purposes comes with certain barriers which might impede students from fully engaging in the immersive environment. The

**Table 6** Summary of task designs

| Task | Number of studies | Description | Intended Outcomes | Potential pitfalls | Examples |
|---|---|---|---|---|---|
| Engaging in informal discussions | 4 | Using VR/AR tools (e.g. VR headsets, google cardboard) students are tasked to engage in informal discussions in the virtual environment. Discussions take place between learners or between learners and non-player characters (NPCs). The focus is on practicing real-time communication in the target language. | -To enhance language performance<br>- To gain language input and produce language output via their interaction<br>-To develop communication skills (listening, speaking, writing) | Limited space and time<br>Expensive equipment<br>Technology availability and compatibility<br>Technical issues<br>Motion sickness | [29, 40, 58, 63] |
| Carrying Role play tasks | 14 | The users follow a specific scenario, have a specific role (e.g. nurse) and come to communicate (mostly orally) with other users (real or avatars) in a virtual environment | - To improve oral proficiency and willingness to communicate<br>-To improve oral fluency for specific purposes (e.g. clinical context)<br>- To recognize and handle conflicts/ decisions | Difficulties while talking with avatars<br>Greater cognitive load<br>Less fluent speech<br>Class time constraints<br>Limited feedback from instructor | [33, 34, 45, 48] |
| Carrying Peer tutoring/ Dyadic task | 2 | Students have roles of tutors and tutees in a VR-enhanced interactive learning system. Tutors are provided with guiding questions to guide tutees' exploration of the VR environment. The tutee answers the tutor's question based on the information obtained in the VR environment | -To enhance students' English-speaking practices<br>- To support collaboration | Challenging to promote students' learning engagement and peer interactions | [42] |
| Conducting closed outcome task | 2 | Students are asked to perform a specific task (e.g. move objects, match objects with words/characters, perform a nursing task, color words, form paragraphs, repeat words,<br>spot vocabulary in real-world contexts) in the VR/AR environment following the instructions given depending on the learning objective | -To experience a simulated context (e.g. medical context)<br>-To improve language learning (vocabulary, paragraph/writing structure, prepositions)<br>-To increase awareness of semantic radicals<br>-To improve long-term memory, motivation, and self-regulated cognition | Requires virtual literacy of the learner<br>Loss of direction, sore eyes, and neck pains.<br>Technical issues<br>Need for more teacher support<br>Increased cognitive load<br>Time consuming | [36, 43, 46, 47, 54, 61] |
| Exploring XR environment | 8 | Students are learning through their avatars after being exposed to content intentionally integrated within a virtual environment (such as SL) (e.g. navigating to another country and being exposed to the target language and culture, being immersed in a treasure hunt task, interact with VR/AR elements) | - To improve target language learning, vocabulary and culture awareness<br>- To reduce the learners' foreign language anxiety<br>- To immerse in a situation with virtual elements and then perform a traditional writing task (e.g. write a paragraph based on virtual elements seen) | Students are likely to be demotivated by the feeling of too much freedom<br>Technical difficulties | [37, 39, 41, 64] |
| Creating XR Content | 5 | Students view, design, create and share VR/AR content (e.g. video or/and voice recordings, narrations, images, etc.) aiming to demonstrate a specific culture or points of interest. | To increase language learning motivation and increase cultural awareness<br>To increase multimodal literacy | Technical difficulties<br>High cognitive loads in the VR environments. | [30, 38, 44, 50] |

barriers as identified from the dataset, were grouped in three categories: (A) Technical Limitations; (B) Health and Safety Concerns; and (C) Pedagogical challenges. Since some of the manuscripts demonstrated more than one barrier, the total number of studies is not equal to the number of the dataset.

#### 3.6.1 Technical limitations (*n* = 15/33)

Technical limitations refer to difficulties encountered due to the nature of the XR technologies. Writing or reading long texts might not be suitable for XR. For instance, a major challenge when designing the VR environment for learning writing structure revolved around how to comfortably render a large amount of text for the participants (e.g [46, 47]). Similarly, using a smartphone and a VR headset al.ong with note-taking function in VR, indicated that the screen was small and not very clear [56]. Moreover, difficulties in alerting learners on their mistakes as well as difficulty in balancing VR features with attractiveness, motivation and learning objectives were highlighted [33]. For example, it was found to be challenging to promote students' learning engagement and peer interactions in VR-based activities that involve peer-tutoring [42]. Moreover, students reported difficulties caused by accents, speed and vocabulary while carrying out oral role-play interpreting tasks [55]. Additionally, limited VR features [64] raised the need for more varied, VR environments and various levels of tasks [56]. Finally, the high-cost of XR, the need of strong internet connection and the requirement for high-performing devices for XR-supported activities are also highlighted [40].

#### 3.6.2 Health and safety concerns (*n* = 7/33)

Health and safety concerns that were identified, are related to motion sickness (e.g., dizziness, loss of direction, headaches) and discomfort and physical strain (neck pain, sore eye). Multiple instances of motion sickness were demonstrated in the corpus. Specifically, in the study of [40], learners reported dizziness with the use of VR goggles in SL due to near-sightedness, resorting to their smartphone app on some occasions to watch the VR video. Some concerns of the Chinese Nursing students related to health problems when using the Modern Operation Room included loss of direction, sore eyes, and neck pains [43]. Students complaining about headaches caused by "too many sounds" and "too much time spent in Second Life" was also part of the recorded barriers [58]. Additionally students reported feeling dizzy and uncomfortable when wearing VR glasses for prolonged periods. In cases where the text in VR was too close to the users, they had to frequently move their heads and neck, causing unwanted discomfort and physical strain on their eyes. Instructors and practitioners who wish to design a VRLE for writing need to take this into consideration since users may not want to use the VRLE for a long time due to frustration and strain [47, 54]. An additional barrier found by [46] was the overheating of the VR headset, which could apply pressure to the participants' glasses or faces.

#### 3.6.3 Pedagogical challenges (*n* = 13/33)

Pedagogical challenges were also reported. These include cognitive load challenges, inappropriate time allocation often leading to frustration [47, 60] and highlighting the need for training and support. For example, the role-play task implemented in [48], indicated slower and less fluent speech when performed in VR rather than on the computer, that might have been due to greater cognitive load in immersive VR (e.g. 360°navigation, multimodal input, and extensive contextual processing). AR-based learning at an authentic learning site was found to be time-consuming due to its nature, requiring more time to be spent on instruction [28]. Additionally, when students ask for help regarding the use of the VR tools during the learning activities, leads to less time spent in VR and the actual speaking or other learning activities [32].

The use of XR supported activities was sometimes related to lower levels of confidence and motivation [58, 60], increase or no effect on anxiety levels [41]. Finally, students, and especially those with no prior knowledge on using XR technologies, might need more support [43, 51, 61]. Similarly, teachers should be trained and supported in creating contents, designing tasks and XR-supported activities [40].

## 4 Discussion - conclusion

The current study aimed at capturing recent XR technologies in language learning for specific purposes.

The first research question aimed to identify the existing XR applications for FLE for specific purposes. Increased attention was directed towards VR applications for language learning for specific purposes (e.g [30, 48, 65]), rather than on AR or MR applications. Only one study was found to focus on MR applications [39], while four studies were found to focus on AR [36–38]. In line with previous studies [66], modern cardboard and mobile technologies, along with integrated simulations produced by XR, enable a highly engaging learning experience. The reason behind this might be related to a general lack of AR and MR applications, as well as to low hardware availability.

The second research question sought to identify the benefits, facilitators, promoting factors, barriers and potential pitfalls related to the implementation and application of XR in FLE. Facilitators were identified prior, during and after the XR activity. Facilitators pertain to the instructional design, provision of training prior to use, appropriate software selection, and alignment of technology-supported intervention with the lesson objectives. This review highlights that both students' and teachers' familiarity with XR technologies plays a crucial role in their overall learning and teaching experience. When it comes to the benefits related to the implementation and application of XR in FLE, XR technologies can create authentic contexts for foreign language use and initiation of real-world linguistic interactions for specific purposes and enhancement of language learning experience [33, 48]. Such experiences, can support situational practice of occupational, research or academic language skills. In addition, XR may have a positive impact on the students' efficacy for creative thinking [44], confidence, and motivation and facilitate the improvement of language proficiency as well as the development of students' multimodal skills [40]. Apart from the benefits, barriers and potential pitfalls also arise from the use of XR applications. The most common barriers when using XR technologies can be classified in three broad categories: technical limitations, pedagogical challenges and health and safety concerns.

To answer the third question, a variety of tasks were found in the dataset for implementing XR in for language learning for specific purposes in the classroom. The task designs that were extracted were grouped into six categories and included informal discussions; role play tasks; peer tutoring/dyadic task; closed outcome tasks, exploration of XR environment; and creation of XR content communication tasks. The intended outcomes focus on supporting communicative competence development of skills like speaking, reading, listening, and writing, as well as 21st century skills such as creativity through the creation of VR content.

With regards to the classroom orchestration practices applied, solo use of the XR technologies with students working mainly individually within the environment prevail. A possible explanation of this result might be the lack of XR technology devices as well as the time and space constraints of typical lessons [29]. Previous research also supports that learning academic material and skills through VR is frequently less effective than learning through traditional media [67], whilst students prior knowledge also affects their learning experience [61]. We, therefore, need to bear in mind the teaching and learning circumstances in which XR learning has or could have added value.

## 4.1 Implications for practitioners

The following recommendations have been developed through the analyses of the results and aim to guide further XR implementation in language learning contexts:

### 4.1.1 Instructors´ preparation prior to the implementation of the activity

Teaching objectives, pedagogical concerns, and learners background and prior knowledge must all be considered by educators when preparing the integration of XR for language learning for specific purposes in their lessons [58]. A set of tasks for the students to perform within the XR environment should be prepared in advance [58]. Those tasks could include role-play activities, informal discussions, peer tutoring, closed outcome tasks, XR environment exploration and content creation related to the specific purpose of the course. The instructor should also determine the conditions in which XR technology can improve language learning.

### 4.1.2 Decide when to implement XR technologies and the tasks

The use of XR technologies for FLE for specific purposes might not always have a positive impact on the learner. Some tasks might be less adequate to be implemented in XR environments than others. For example, writing tasks were found to be uncomfortable for users in XR environments [47], while authentic and immersive environments such as visiting places, as well as role-play activities make language learning more efficient and autonomous [43, 50]. Moreover, participants' task performance in oral fluency and linguistic strategy choice is influenced by social-interpersonal aspects, such as who one talks to and for what goals (i.e., less fluent speech). Different task types need to be designed in order to gauge participants' capacity to complete a variety of task kinds [48]. Taking advantage of the technology features (e.g., speech recognition, immersion, interactivity) can support the design of tasks that increase students' motivation and engagement such as location-based exploration, role-play, and guided dialogue with avatars and/or other players. Finally, providing interactive and hands-on activities in the XR environment such as content creation improves students' multimodal literacy [38].

### 4.1.3 Students' preparation

Students should be informed and prepared by the instructor for the upcoming activities using XR. Those who are unfamiliar with XR need to be instructed on how to use it, for instance, by providing training sessions and instructions on the use of technology before the activity takes place. An effective way to prevent lengthy time in class preparing students is by providing them with electronic resources such as images of what they expect to see in the XR environment. It is also important to instruct students on how to use XR safely, for example, they must not reveal their own identity or give personal information. They should also be given the option of declining to complete the activity if they feel like doing so [58]. Moreover, some content might be necessary to be taught before the VR activity implementation [54].

### 4.1.4 Scaffold interaction during the activity

The instructor should scaffold the interaction of the students with the XR environment by giving them tasks or challenges to complete [58] and also encourage them to use the technology voice features to motivate them improve their speaking in the target language for specific purposes [58]. They should also provide students with conversation-starting and -maintaining tactics, such as engaging discussion topics, general conversation inquiries, etc., as this was found to be intriguing [58]. Remote teacher observation as suggested by [61] may also minimise disruption and further support scaffolding when needed. Moreover, guided dialogue enables the mediation of the students' education in accordance with their learning preferences and interactivity, both of which are beneficial in online settings [33]. Thus, structured guidance can be provided to students in order to bridge interaction activities with others either within the VR environment or within the physical environment when using AR. In the case of SL, students can be provided with a list of places where they might find speakers of the target language who are willing to engage in conversation in XR worlds [58]. In the case of AR, scaffolding could support students' productive skills, cognitive processes, and motivation [36].

#### 4.1.5 Flexibility

Activities in XR environments should allow flexibility to use both within and outside of the classroom to enhance learning experiences, for example by creating or using an existing activity in SL that students can engage beyond the classroom. While XR applications have the capability to provide realistic and authentic environments, they can be applied in various contexts (e.g., city tours, hospitals, etc.) and enhance language learning for specific purposes (e.g., tourism, nursing, etc.).

#### 4.1.6 Focus on language learning in real-life contexts

Learners are more engaged, motivated, and prepared to meet the demands of the task when assignments are connected to the real world and draw on their cultural, linguistic, and global knowledge [65]. Teachers should work to create a supportive learning environment where reality, virtuality, and mindset interact ecologically in order to break down the language barrier and put more emphasis on how language is used in practical situations for specific purposes close to the knowledge and interests of the students [43].

### 4.2 Implications for researchers and instructional designers

The following recommendations have been developed through the analyses of the results and aim to guide further XR research in language learning for specific purposes:

#### 4.2.1 Collaboration with students and designers

Language instructors and students should collaborate with researchers and designers to assess learning goals, define technological requirements, and provide tailored technical support. Teachers must be able to resolve technological concerns immediately, and the equipment must be comfortable. For example, a "Quick Help" function might be introduced to give teachers and students prompt assistance [43].

#### 4.2.2 Further research on AR and MR for language learning for specific purposes

The majority of the applications for language learning for specific purposes was found to be in a VR environment. Limited studies were found to focus on AR and MR applications for language learning for specific purposes. Provided that AR is rapidly becoming accessible and no longer requires expensive hardware or sophisticated equipment [68]. We encourage future research to focus on AR and MR applications in language learning for specific purposes. Further research on the development of XR applications with closed collaboration with professionals of different fields would ensure the exchange of ideas, as well as timely integration of novelties into FLE for specific purposes.

### 4.3 Limitations

Some important limitations of this study need to be considered. The most important limitation lies in the fact that some articles referring to MR, AR, or VR applications might be excluded from the dataset since it was decided to confine the dataset to a limited timeframe and draw academic publications from specific databases using specific keywords. Another potential limitation is that the scope of this paper may be too narrow as it focuses on XR applications for FLE for specific purposes. Therefore the reader should bear in mind that the XR applications presented are not exhaustive nor their benefits and affordances can be generalised for all XR applications. Finally, the study's conclusions and recommendations might not be generalizable to all XR applications or all educational contexts.

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## Declarations

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